Tutorial 3

Oscillations

1. Find the differential equation of motion for a gravitational pendulum of mass m and length a by using the fact that the torque of its weight relative to the point of suspension is equal to the time derivative its angular momentum. Solve this equation to obtain the equation of motion in the small oscillation approximation, by considering that initially the pendulum at rest makes an angle θ_0 with the Oy axis (vertical).
2. You are on a boat that is bobbing up and down. The boat's vertical displacement y is given by:

$$y = (1.2\text{m})\cos\left(\frac{t}{2\text{s}} + \frac{\pi}{6}\right).$$

a) Find the amplitude, angular frequency, phase constant, frequency, and period of the motion. b) Where is the boat at $t = 1\text{s}$? c) Find the speed and acceleration at any time t. d) Find the initial poison, speed, and acceleration of the boat.

3. An object oscillates with angular frequency $\omega = 8\text{rad/s}$. At $t = 0$ the object is at $x_0 = 4\text{cm}$ with an initial velocity $v_0 = -25\text{cm/s}$. a) Find the amplitude and the phase constant for the motion. b) Write x as a function of time.
4. Consider an object on a spring whose position is given by the equation: $x = (5\text{cm})\cos\left(9.90\text{s}^{-1}t\right)$. a) what is the maximum speed of the object? When does this maximum speed first occur? b) What is the maximum acceleration of the object? When does this maximum acceleration first occur?
5. The total energy of a particle executing a simple harmonic motion of period 2π seconds is 10.24×10^{-4} Joule. The displacement of a particle at $\frac{\pi}{4}$ seconds is $0.08\sqrt{2}$ meters. Find the amplitude and mass of the particle.